

Airborne Measurements of Formaldehyde During INTEx-NA Employing A Tunable Diode Laser Absorption Spectrometer

The Analytical Photonics and Optoelectronics Laboratory (APOL) at the National Center for Atmospheric Research (NCAR) plans to fly the Dual Channel Airborne Laser Spectrometer (DCALS) instrument for highly sensitive, accurate, and selective measurements of formaldehyde (CH_2O) during the INTEx-NA study. This instrument utilizes the technique of tunable diode laser absorption spectroscopy (TDLAS), detailed descriptions for which can be found in the reference list. This list also includes recent airborne and ground-based measurements, inlet tests, assessment of instrument performance, and detailed airborne measurement-model comparisons.

The tunable diode laser instrument measures ambient CH_2O by measuring the absorption of IR radiation at $3.5\text{-}\mu\text{m}$ as ambient air is continuously sampled through a multipass absorption cell (55 cm base path and a 100-meter optical pathlength) at reduced sampling pressures around 50 Torr. The IR diode laser beam is absorbed by CH_2O at this wavelength, and with the exception of a small spectroscopic interference from methanol (3.5%), the absorption at $3.5\text{-}\mu\text{m}$ (more specifically 2831.6417 cm^{-1}) is very selective for CH_2O . The final submitted data will be corrected for this small interference using methanol measurements from two different instruments operated onboard the DC-8 aircraft. Absorption measurements are carried out as the diode laser is repetitively scanned over this same absorption feature using the technique of sweep integration coupled with second harmonic detection. Retrieved CH_2O mixing ratios are determined in real time at a frequency from 1 second to 1 minute, depending upon the desired measurement precision. At 1 second, typical (1σ) measurement precisions range from 150 to 200 pptv, while the precisions for 1 minute range between 20 to 50 pptv, with most values falling within the 25 – 40 pptv range. Ambient mixing ratios, which are determined without the need for pre-concentration and/or trapping in the liquid phase, have a measurement accuracy of 10 – 15%.

During INTEx-NA, the DCALS instrument will be operated on the NASA DC-8 platform and will report ambient CH_2O mixing ratios at a time resolution of 1-second in the boundary layer where fast response in pollution plumes are required. Longer averaging times will also be reported for low ambient mixing ratios characteristic of the middle to upper troposphere. As in past studies like the NARE-97, TOPSE 2000 and the TRACE-P 2001 campaigns, we will work closely with modelers to compare our CH_2O measurements with box model calculations. We plan to pay particular attention to comparisons: in clouds; near the ocean surface in the presence of marine aerosols; and in background air in the middle to upper troposphere, particularly when sampling stratospheric air. Such comparisons during past missions have revealed some very interesting results, and the present comparisons will afford the opportunity to revisit these regimes with some vast improvements in instrument design and data reduction procedures. The modified DCALS instrument has incorporated many new algorithms to further ensure high data quality.

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